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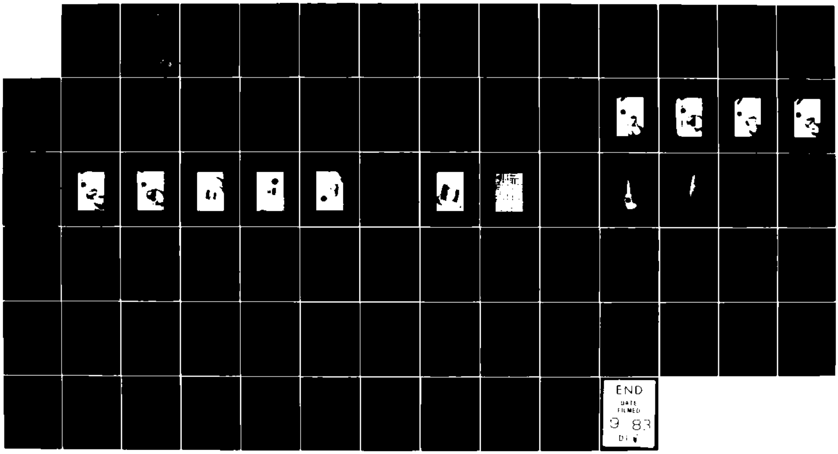

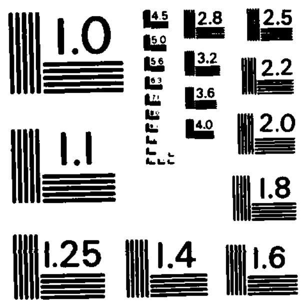

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A COMPARISON OF ARCH WIDTH WITH ANGLE

CLASSIFICATION AND WITS APPRAISAL IN

CLASS II DIVISION 1 AND CLASS I INDIVIDUALS

by

Wendell R. Stuntz

A thesis submitted in partial fulfillment
of the requirements for the degree of
Master of Science in Orthodontics
in the Graduate College of
The University of Iowa

May, 1983

Thesis supervisor: Associate Professor Robert N. Staley

Graduate College
The University of Iowa
Iowa City, Iowa

CERTIFICATE OF APPROVAL

MASTER'S THESIS

This is to certify that the Master's thesis of

Wendell R. Stuntz

has been approved by the Examining Committee for the thesis requirement for the Master of Science degree in Orthodontics at the May, 1983 graduation.

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INTRODUCTION

One of the common problems which must be dealt with in Orthodontics is a tranverse malrelationship or buccal crossbite of the posterior teeth. Many clinicians believe that this problem is highly correlated with the type or classification of malocclusion. A commonly expressed opinion is that individuals with Class II division 1 malocclusion are most likely to manifest a transverse malrelationship due largely to an underdeveloped width of the maxilla, particularly in the molar region. Therefore this study was undertaken to determine whether or not individuals with Class II division 1 malocclusion ~~do indeed~~ have a narrower maxilla than Class I normal individuals.

It is the purpose of this study to measure the upper and lower arch widths in individuals with Class II division 1 malocclusion and with normal occlusion to determine (1) whether or not the upper and lower arches of the Class II division 1 sample are different in size from a normal occlusion control sample and (2) what interrelationship exists between the upper and lower arches in Class II division 1 individuals as compared to the interrelationship in a normal occlusion control sample. An additional purpose was to determine what relationships exist between arch width measurements and measurements of anteroposterior and vertical relationships of the arches.

OBJECTIVES

The purpose of this study was to compare and contrast Class I and Class II subjects on the basis of thirteen dental arch and cephalometric variables. The sample was composed of essentially non-growing individuals in an attempt to describe rather than explain the reason for differences, if any, in the groups.

Specific objectives were:

1) to compare maxillary and mandibular canine and molar arch width measurements.
2) to compare maxillary and mandibular basal bone widths in the first molar region.
3) to compare sagittal measurements which relate the maxillary arch tc the mandibular arch both dentally and cephalometrically.
4) to compare vertical measurements both dentally and cephalometrically.
5) to determine, by correlation, what associations may exist among the sagittal, vertical and width measurements.
6) to determine sex differences.

LITERATURE REVIEW

There have been many arch width and skeletal width studies, but none has correlated arch widths or arch width differences to anteroposterior measurements or malocclusion types. A brief review of some of these studies is presented.

Arch Width Development

The literature review is divided into three sections. The following section of the literature review presents articles which document the growth in width of the dental arches. Because the present study was intended to be conducted on essentially non-growing individuals, these articles are presented to demonstrate the rationale for the choice of a minimum age for the subjects selected.

Knott (1961) using 16 male and 13 female Caucasian children measured the interbuccal diameter at the permanent first molars (arch width) from age 9 to late adolescence. Her sample, taken from the Iowa Growth Study, was the same group of Class I individuals from which this study's sample was selected. She found almost no change in mean arch width for either arch in females age 13 years or older. Males showed some increase in mean arch width in both arches after age 16 years but appeared to be only minimally increasing. She also computed correlation coefficients between upper and lower dental arch widths at four ages and found them to be quite high in this "normal" sample. No correlation with Angle classification or apical base discrepancy was attempted.

Moorrees and Reed (1965), using a semilongitudinal sample of 84 male and 100 female North American White children with minimal crowding and spacing, studied arch width and depth at different stages of eruption. They found no increase in mandibular intercanine distance in either sex after the eruption of the mandibular permanent canines. Maxillary intercanine width increased in both sexes as the permanent canines erupted.

Sillman (1964), using a semilongitudinal sample of "65 normal White persons which included thumbsuckers, children with good and poor occlusions, and children who had been treated", demonstrated that mean arch width at the canines and molars in both arches does not increase significantly in males after age 16 years or in females after age 13 years. He did not separate his sample into good and poor occlusion, male and female or Class I and Class II; therefore, no comparison among these groups could be made.

DeKock (1972) studied arch width at the molars in both arches using sixteen male and ten female subjects from the Iowa Growth Study and had essentially the same findings as Knott concerning molar arch width. In females there was no significant change from age 12 to 26 years in either arch. In males there was a small, statistically significant increase in arch width from age 12 to 15 years but none from age 15 to 26 years in both arches.

Knott (1972) studied longitudinal changes in arch width between lateral incisors, canines and second premolars or deciduous second molars at four stages of dental eruption in 22 male and 15 female Caucasian children taken from the Iowa Growth Study. She found that bicanine distance was essentially stable in both arches after the eruption of the permanent teeth. The arch width at the deciduous second molars/second premolars was similar.

Woods (1950) used PA cephalograms and studied skeletal and dental width changes longitudinally in 14 males and 14 females but did not separate findings among Class I, II and III occlusion types. He found from ages 3 to 15 years that 1) the skeletal widths measured increased steadily, 2) upper intercanine width increased gradually except for a decrease from age 7 to 12, 3) lower intercanine width remained fairly constant except for a decrease from age 6 to 11, 4) the width between the upper first molars increased until they came into occlusion and then continued to increase at a much slower rate, 5) the width between lower first molars decreased gradually until these teeth came into occlusion and then remained fairly constant and 6) the principal sex difference was one of absolute size, the female being slightly smaller than the male in all dimensions.

Arch Width Studies - Class I and Class II

The following section of the literature review presents some articles which document skeletal and dental arch studies in Class I and Class II subjects. Each study presented relates to some aspect of the present study yet none pertains to all of the objectives in the present study. Some differences between the previous studies and the present one are also included.

Frankel and Kronman (1966) studied skeletal widths from PA cephalograms and related them to maxillary and mandibular first permanent molar widths in 24 North American Caucasian children with normal occlusion and 48 subjects with malocclusion. They found more variation in the malocclusion group, some moderate, positive correlations between selected skeletal widths and molar widths, and a highly significant correlation between mandibular permanent first bimolar and birotundal breadth in individuals with malocclusions. The malocclusion group was not divided into malocclusion types and no attempt was made to relate arch width or skeletal width to anteroposterior measurements or malocclusion type.

Slagsvold (1971) measured skeletal and dental arch widths at canines, premolars and molars on 83 adult male and 64 adult female skulls. He showed moderate to good correlation in maxillary to mandibular dental arch widths, very low correlation of maxillary to mandibular apical base widths and moderately good correlations between dental arch widths and skeletal widths at the apical base of the same pairs of teeth. He concluded that a soft tissue adjusting mechanism helped guide the teeth into occlusion. No measurements were made to determine if anteroposterior or vertical dimensions were correlated to dental arch or skeletal widths. Also, he made no attempt to divide his sample into normal and malocclusion groups.

Warren (1959) studying twenty-four young adult White males with excellent occlusion found that maxillary denture width measurements (canine and molar) correlated highly with upper facial skeletal width measurements but mandibular denture width measurements, though highly constant, did not correlate highly with bigonial skeletal width measurements. Only Class I individuals were sampled and antero-posterior measurements were not taken.

Solow (1966) examined the pattern of associations among the components of the craniofacial complex in 102 adult male dental students, 20-30 years of age, who had no missing teeth other than third molars and who had not received orthodontic treatment. Among other things he found "jaw widths to be associated with the transverse inclinations of the lateral dental arch segments in the opposite arch, and mandibular length was positively associated with the upper incisor inclination and with the width of the upper dental arch and negatively associated with the lower incisor inclination" suggesting a dental compensating mechanism. He also found that mandibular prognathism was significantly associated with maxillary arch width, molar occlusion and overjet but the correlation coefficients were in the range of .06 to .20. He states that there were no associations between the widths of the dental arches and the sagittal jaw relationship which Bjork (1953) visualized, but could not confirm statistically. He stated "The transverse dentoalveolar adaptation to the sagittal jaw relationship here was evident only as an association between the transverse measurements of the upper dental arch and the length and prognathism of the mandibular base."

Green (1968) used dental casts and cephalograms of ninety Caucasian children from the Iowa Growth Study to determine whether osseous face depths and depth relations in the vicinity of the dentition are associated with sagittal molar relationships. He found that at age 9 years there was no difference in forward projection of either upper or lower jaw between Class I and Class II subjects. He also found that differences between upper and lower face depths were greater for Class II than Class I subjects and occlusal categories showed moderate correlation (r=0.50) with facial depth differences.

Frohlich (1961, 1962) studied Class II individuals based on "51 children from a total of 405 children studied... A few multilated dentitions have been included because of their typical and undisputed Class II configuration, but measurements pertaining to the affected arch were not used for statistical analysis... In general, the period of observation included the transition from the deciduous to the permanent dentition." He subjectively distinguished four subgroups of Class II malocclusions and demonstrated differences among them in terms of arch length, intercanine distance and intermolar distance. He stated that in three of the four groups maxillary intermolar width was narrower than Moorrees's (1959) "normative data". He said Class II division 1 with a V-shaped maxillary arch, Class II division 1 with flaring and spacing of the incisors and borderline category (Class II division 1 - "malocclusion characterized by upright, well-aligned maxillary incisors and a slight to moderate overjet") all had maxillary intermolar widths smaller than the "normative data".

The fourth category was Class II division 2 which had a comparable maxillary intermolar width with the "normative data". Concerning maxillary intercanine width, the Class II division 1 V-shaped arch group had below average width, the Class II division 1 with flaring and spacing had average width and both the borderline group and the Class II division 2 group had above average intercanine width. Frohlich measured overbite, overjet and sagittal molar occlusion but did not correlate them with other parameters. He found no specific trends in the dimensions of the mandibular dental arch other than a statistically significant shorter arch length of the division 2 group compared to the borderline group.

Moorrees (1959) presented normative data based on a semilongitudinal sample of dental casts made on 184 children of Northwest European descent. Approximately one-third of the 184 children "had a normal anatomical occlusion and a full complement of teeth... Other children had malocclusions, dentition mutilated by extractions or agenesis of permanent teeth." His normative standards were based on as few as 8 casts and as many as 57 casts. In some cases one arch from a child was used while the opposite arch was not used due to mutiliation of the dentition. His normative standards were confined to the dentition proper since there were no cephalograms made.

While Frohlich compared his Class II individuals with Moorrees's normative data, some differences between their studies and the present one should be pointed out. Intercanine distance was measured essentially to the same point in this and the previous studies and should therefore be comparable. Frohlich and Moorrees measured intermolar width from the mesiolingual cusp tip of the right first permanent molar to the mesiolingual cusp tip of the left first permanent molar. In the present study maxillary intermolar width was measured between the mesiobuccal cusp tips of the first permanent molars and mandibular intermolar width was measured between the buccal grooves of the first permanent molars. The upper and lower intermolar width distances in the present study should be very close in their absolute measure, if the teeth are in a normal relationship, since the mesiobuccal cusp tip of the maxillary first permanent molar occludes in the buccal groove of the mandibular first permanent molar in neutro-occlusion. Moorrees's and Frohlich's method would obviously yield smaller values which would differ in absolute numbers if the teeth were in normal occlusion. The present study also differs from Frohlich's work in that all Class II individuals studied were full-step Class II, both arches were included in the statistical analysis and all individuals studied were essentially non-growing with complete dentitions. The Class I normals used for comparison purposes were taken from the same general population as the Class II subjects and were likewise non-growing with complete dentitions. All arches of all individuals studied were included in the statistical analysis.

Wits Appraisal

The following section of the literature review presents two articles which describe the Wits appraisal, in order to help explain its use in the present study.

Jacobson (1975) demonstrated the use of the Wits appraisal and its application to aid in the diagnosis of anteroposterior jaw disharmony. He pointed out that the angle ANB is traditionally used as a measure of this skeletal disharmony. Through the use of examples and geometric relationships he explained how the angle ANB is affected by the relative position of point N to the denture bases and the angulation of the occlusal plane. By comparison, the Wits appraisal does not rely on the cranial base for reference, but only relates one denture base to the other in terms of the occlusal plane. He then listed normative data for the Wits appraisal based on excellent occlusion samples of twenty-one and twenty-five adult males and females respectively. He concluded that the Wits appraisal is a more accurate determinant of relative jaw disharmony than ANB because ANB relates the denture bases to cranial reference points while the Wits appraisal relates one denture to the other only in terms of themselves.

Rotberg, Fried, Kane and Shapiro (1980), using lateral cephalograms taken on 25 White males and 25 White females who were orthodontically untreated age 10 to 14 years, showed the relatively low correlation between the Wits appraisal and the angle ANB. They showed that one could not use either to predict the other, and how the relative position of Nasion has a very significant effect on the ANB angle. They drew no conclusions, but one might surmize that the Wits appraisal is a more direct measurement of the true relative positions of the upper and lower arch apical bases.

MATERIALS AND METHODS

Sample

Data was collected on the following groups of records from the University of Iowa Orthodontic Department and the Iowa Growth Study.

	Males	Females
Class I normals (Iowa Growth Study)	19	17
Class II division 1 malocclusion	20	19

The Class I normals were selected from the Iowa Growth Study. This program was begun in the spring of 1946 by Howard V. Meredith and L. B. Higley and includes cephalograms and plaster models (among other records) on 92 boys and 91 girls.

Dental casts were made twice each year and cephalograms were taken every three months through age 5, semiannually through age 12 and annually through age 17 years. All subjects had clinically acceptable occlusion with the dentures appearing to be well oriented with respect to the face. Ninety-seven per cent of the subjects were of Northwest European ancestry and were entered into the program based upon willingness to participate and probability of continuing residence in the Iowa City area. Enrollment was not based upon orthodontic need. Material for this study was all males and females available from the Growth Study according to the following criteria:

1) Class I molar relationship (bilateral)

2) Minimum age of subject was 16 years for males and 13 years for females

3) Well aligned dental arches with less than 3 mm crowding or spacing in either arch

4) A lateral cephalogram taken in centric occlusion present for the same age as the casts selected

5) A full complement of fully erupted permanent incisors, canines, premolars and first molars present on both sides of the maxillary and mandibular arches

6) Casts with chipped teeth or casts that could not be reliably occluded in centric occlusion were rejected

7) No previous orthodontic treatment

8) Caucasian

The Class II division 1 malocclusions were selected from cases which were treated at the University of Iowa College of Dentistry Orthodontic Department between the years 1960 and 1982. Their inclusion in the study was based on the following criteria:

1) Class II molar relationship - the distobuccal cusp tip of the maxillary first molar falling within 1 mm either side of the buccal groove of the mandibular first molar in centric occlusion

2) Maxillary central incisiors which were judged to be protrusive so as to avoid inclusion of Class II division 2 subjects

3) Pretreatment models were used; minimum age was 15 years 8 months for males and 13 years for females
4) Lateral cephalograms taken in centric occlusion corresponding to the pre-treatment models were used
5) A full complement of fully erupted permanent incisors, canines, premolars and first molars present on both sides of the maxillary and mandibular arches
6) Casts with chipped teeth or casts that could not be reliably occluded in centric occlusion were rejected
7) No previous orthodontic treatment
8) Caucasian

Measurements

The following measurements were taken in order to quantify the transverse, vertical and anteroposterior relationships studied.

Transverse Measurements

Six transverse measurements were made on each set of models. The intermolar width in the maxillary arch (see Figure 1) was measured from the mesiobuccal cusp tip of the right first permanent molar to the mesiobuccal cusp tip of the left first permanent molar. The intermolar width in the mandibular arch (see Figure 2) was measured from the most gingival extension of the buccal groove on the buccal surface of the right first permanent molar to the homologous point on the left first permanent molar. The intercanine width of the maxilla (see Figure 3) and mandible (see Figure 4) were measured

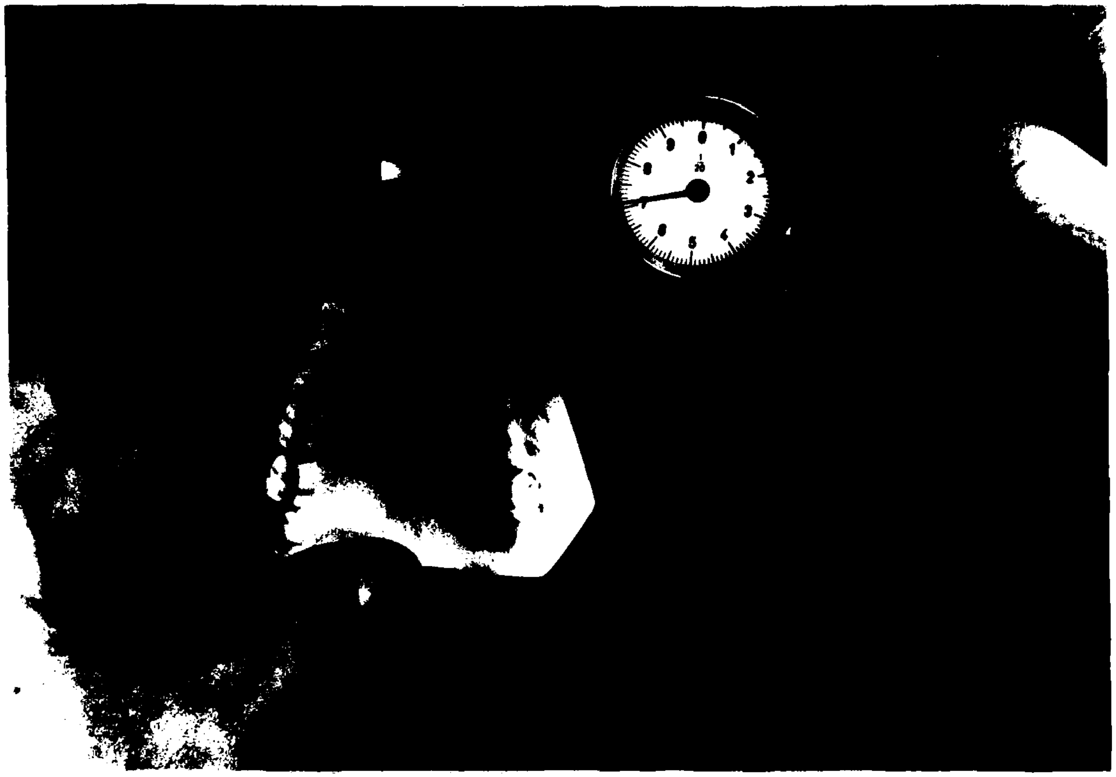

Figure 1. Maxillary intermolar width measurement.

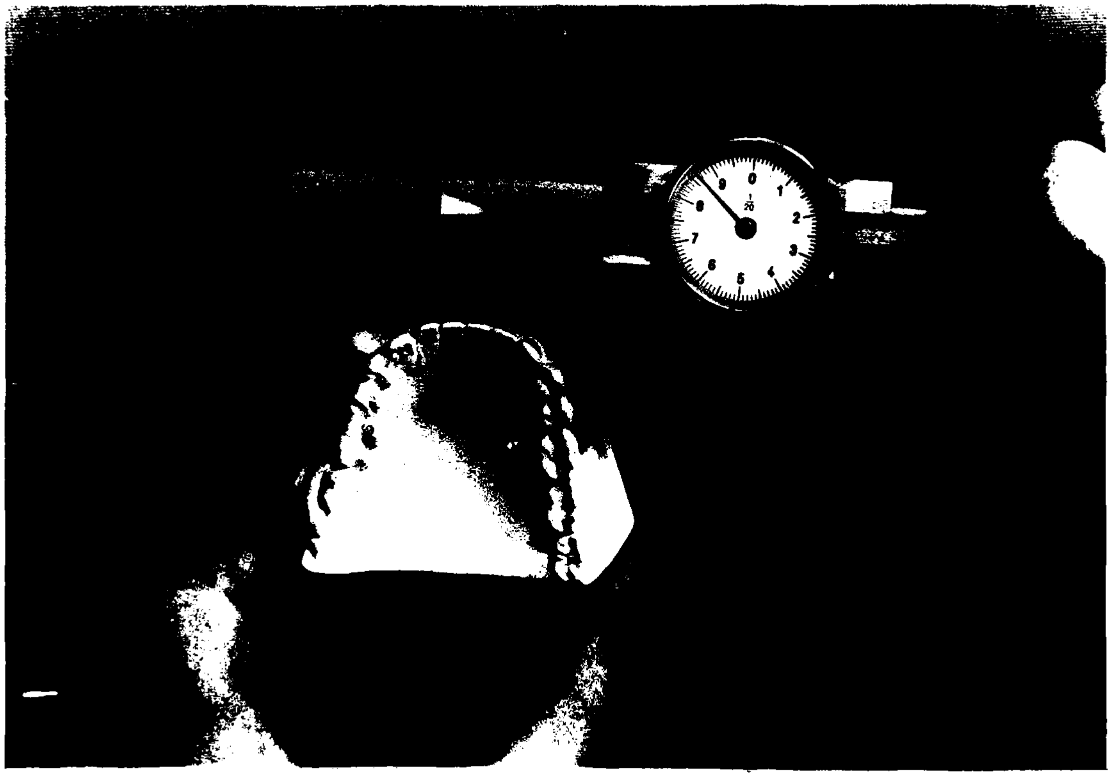

Figure 2. Mandibular intermolar width measurement.

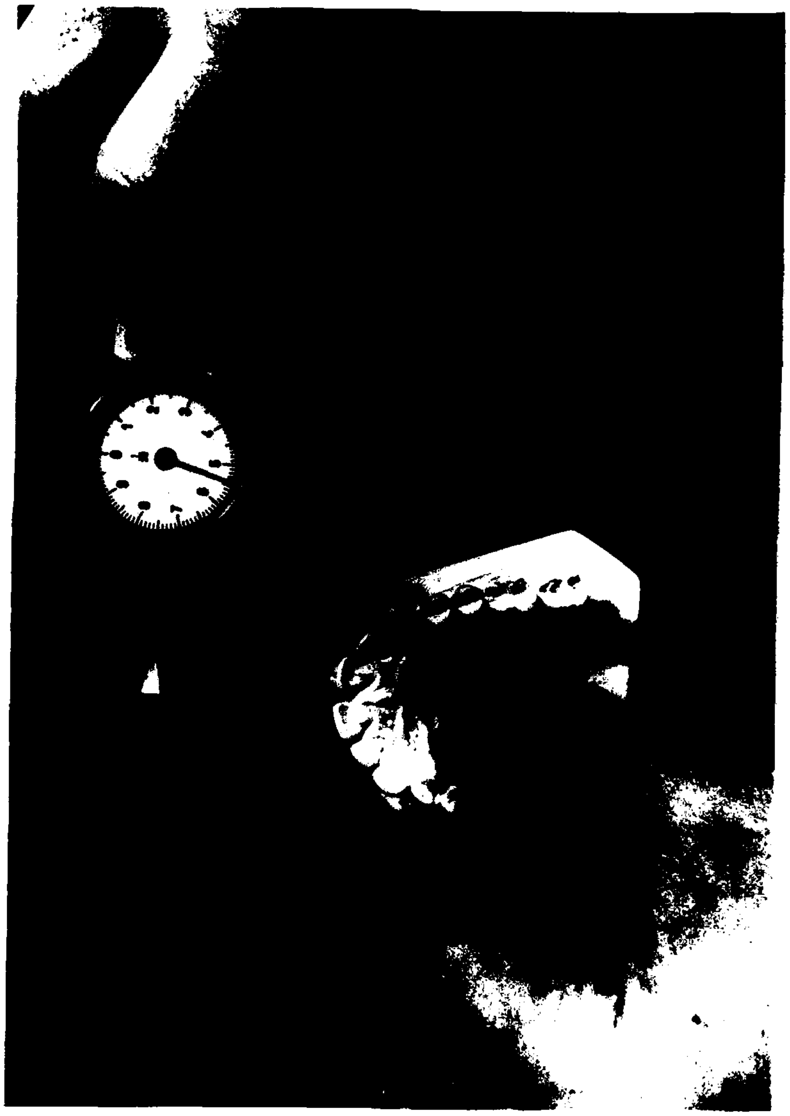

Figure 3. Maxillary intercanine width measurement.

Figure 4. Mandibular intercanine width measurement.

from the cusp tip of one canine to the cusp tip of its antimere. The maxillary alveolar width (see Figure 5) was measured from a point directly superior to the mesiobuccal cusp tip of the maxillary first permanent molar at the level of the mucogingival junction to the homologous point on the opposite side of the arch. The mandibular alveolar width (see Figure 6) was measured from a point directly inferior to the buccal groove of the mandibular first permanent molar at the level of the mucogingival junction to the homologous point on the opposite side of the arch. All points were marked on the casts with a pencil prior to measurement.

Vertical Measurements

Overbite was measured from the cast material as a vertical determinant. The overbite, the amount of vertical overlapping of the mandibular incisors by the maxillary incisors, was measured by scribing a fine line level with the occlusal plane on the mandibular incisor directly lingual to the most labial maxillary central incisor near the midline (see Figure 7). This line was determined with the casts articulated in centric occlusion. The distance from the line to the incisal edge of the scribed incisor (see Figure 8) was measured as well as the distance from this line to the most cervical aspect of the free gingival margin (see Figure 9). Overbite was then defined as the ratio of the first distance (from the line to the incisal edge) to the total of the two measurements expressed as a percentage.

A second vertical measurement used was the angle formed by the intersection of the Sella-nasion line and the mandibular plane

Figure 5. Maxillary alveolar width measurement.

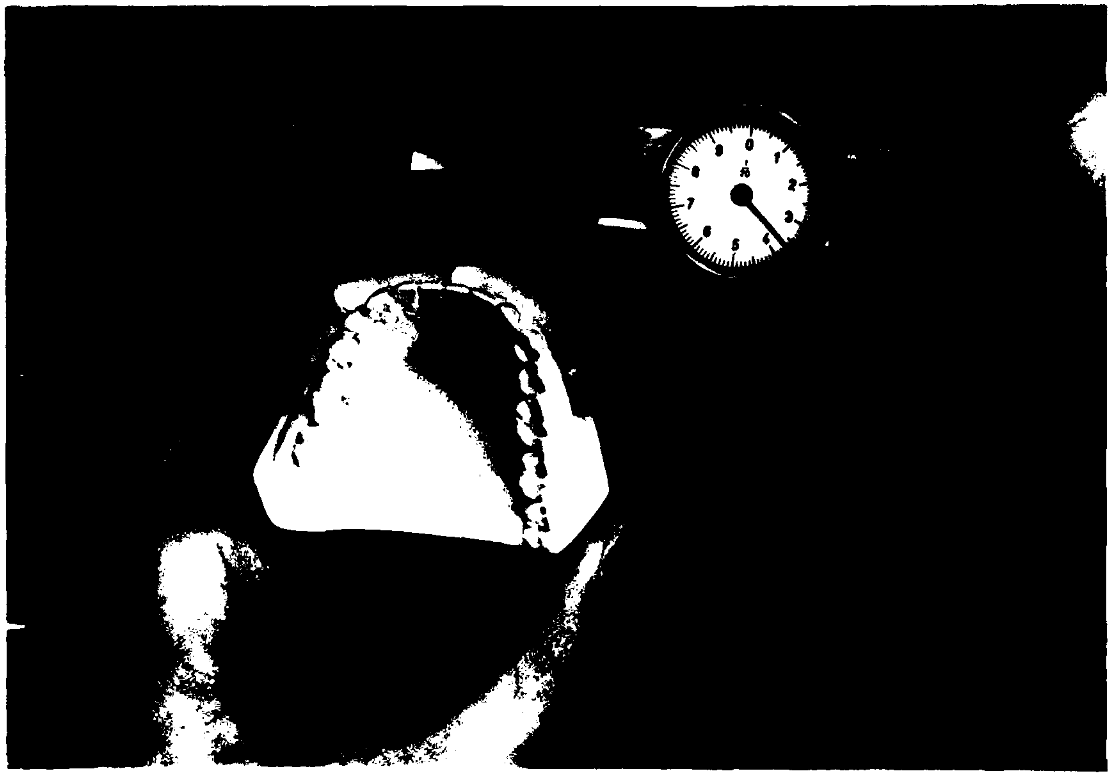

Figure 6. Mandibular alveolar width measurement.

Figure 7. Scribing of line for overbite and overjet measurements.

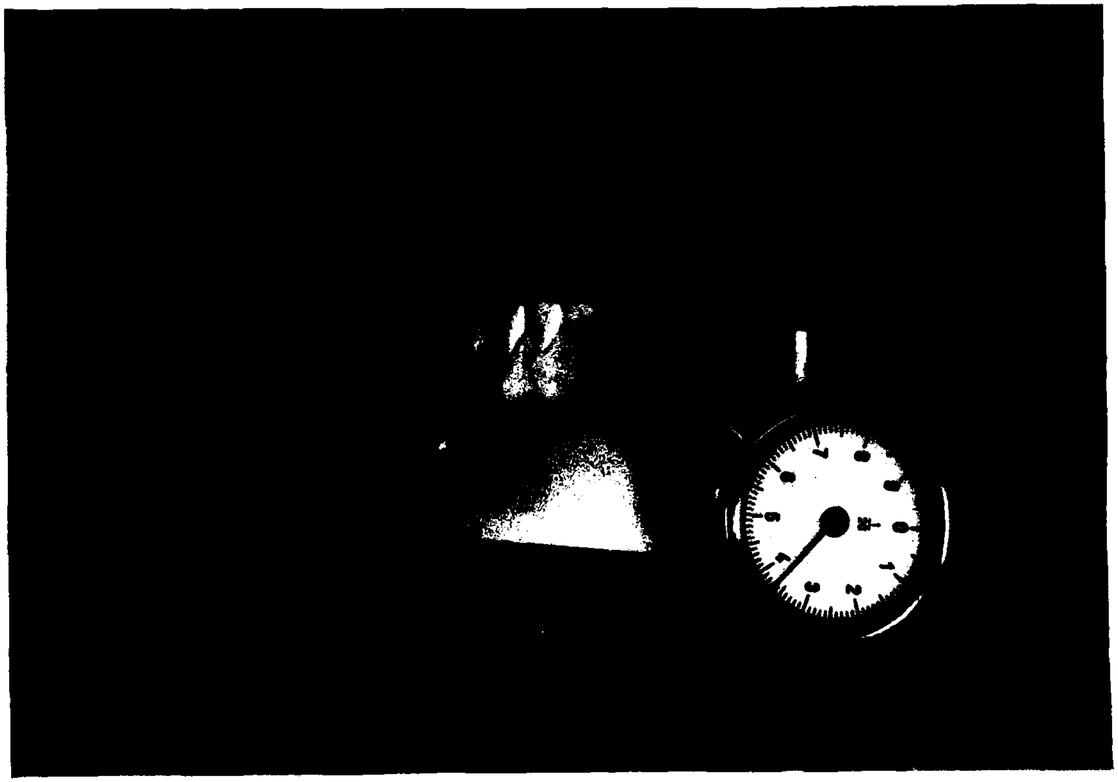

Figure 8. Scribed line to incisal edge measurement.

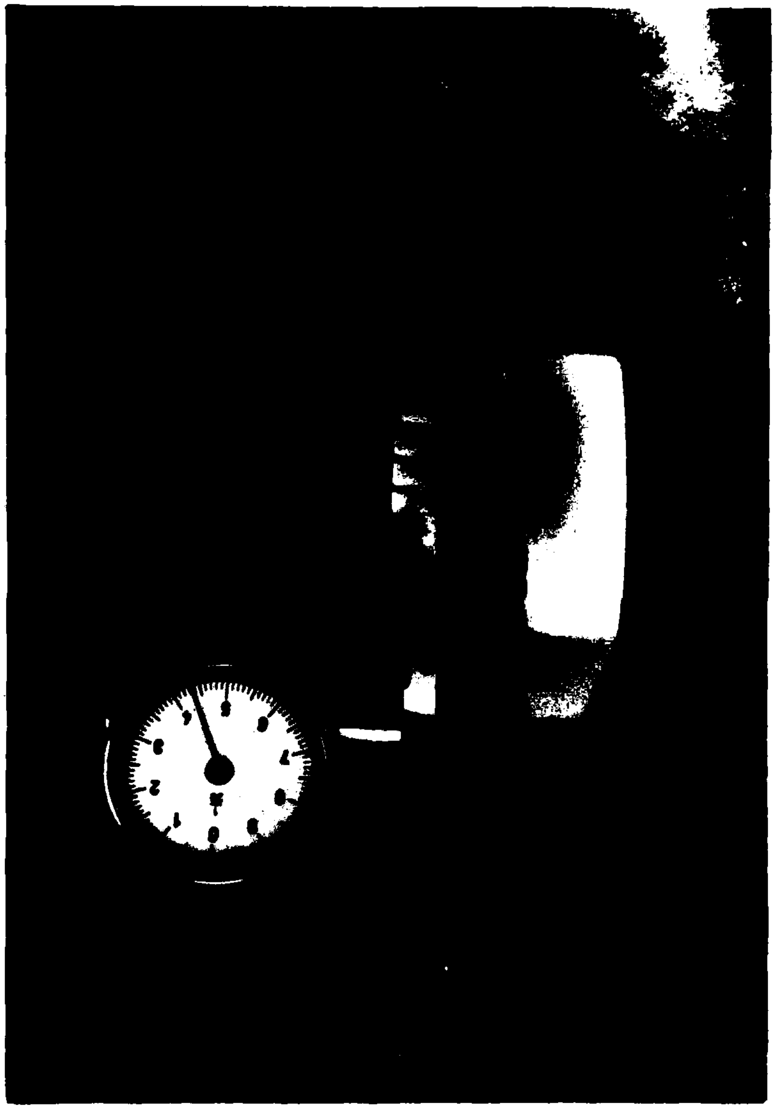

Figure 9. Scribed line to free gingival margin measurement.

line (Menton-Gonion). This measurement, the mandibular plane angle, was made to the nearest 0.5 degree.

Anteroposterior Measurements

Overjet was measured from the cast material as an anteroposterior parameter. The overjet, (see Figure 10) the amount of horizontal overlap of the maxillary incisors anterior to the mandibular incisors, was determined by measuring from the scribed line on the labial surface of the mandibular incisor to the most labial maxillary incisor along the occlusal plane. The depth rod on the calipers was placed against the labial surface of the mandibular incisor and the calipers then adjusted until the beam portion touched the labial surface of the maxillary incisor.

The Wits appraisal was used as a measure of the relative anteroposterior relationship of the maxilla and mandible. The cephalograms were "pricked" at points A and B and a point midway between the incisal tips of the most labial maxillary and mandibular central incisors and a point on the occlusal plane at the buccal groove of the mandibular first molar. A piece of clear celluloid paper with a 1 millimeter grid and X and Y axes drawn on it was then placed over the cephalogram. The X axis was placed over the two points on the occlusal plane such that the Y axis coincided with Point B. The distance Point A was anterior or posterior to the Y axis was read off of the grid to the nearest 0.5 millimeter. If Point A was anterior to the Y axis the measurement was positive, if it was posterior to the Y axis it was negative (Figure 11).

Figure 10. Overjet measurement.

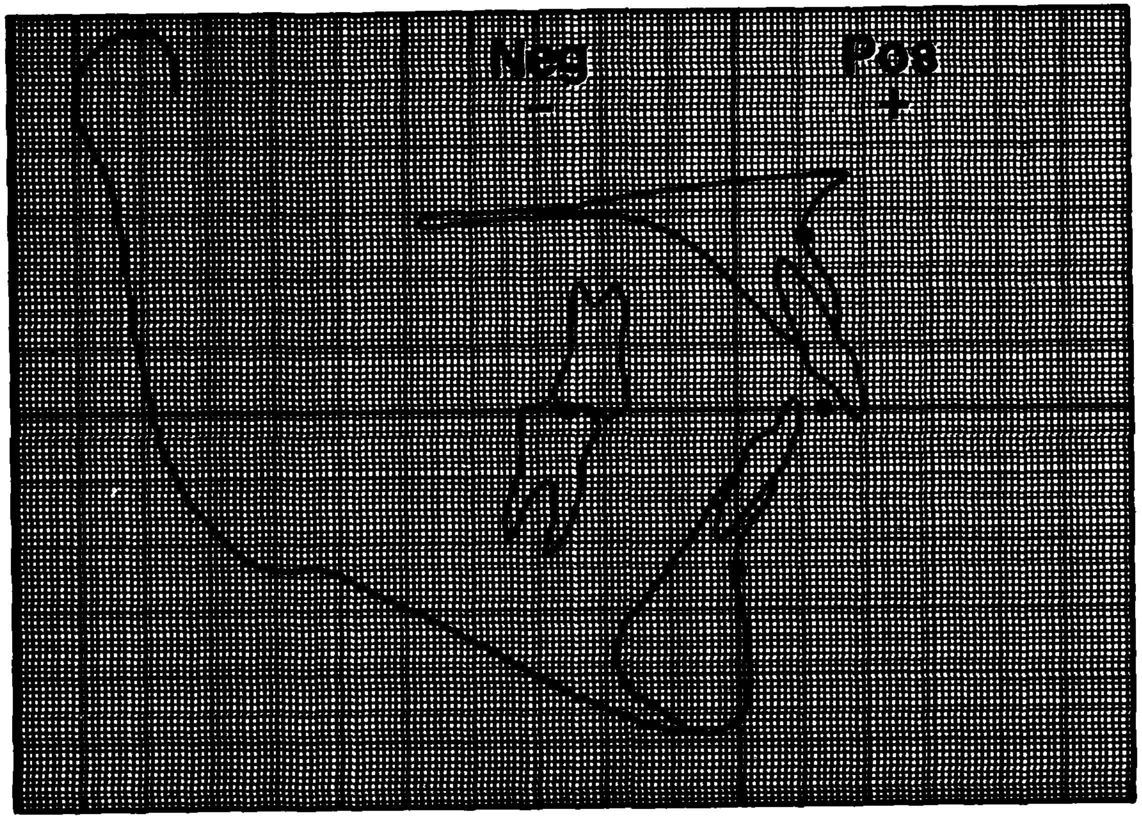

Figure 11. Wits appraisal measurement.

Measurement Instruments

A Helios dial calipers capable of measuring to the nearest 1/20th (0.05) millimeter was used for transverse measurements as well as overbite and overjet measurements on the cast material (Figure 12). A millimeter grid paper was used for making the Wits measurement. A Baum cephalometric protractor was used to measure the mandibular plane angle (Figure 13).

Measurement Reliability

Two investigators (W.S., J.R.) each recorded double measurements of all variables in each sample. Each second measurement was recorded independently of the first so that one measurement would not prejudice the other. An inter examiner correlation was run and found to be $r = 0.99$. The intra examiner correlations for W.S. ranged from $r = 0.997$ to 0.999 for the eleven measurements. The first and second measurements of the first investigator (W.S.) were averaged and used in the subsequent statistical analysis. The Wits appraisal measurements were corrected by multiplying the mean of the first and second measurements by the proper magnification factor.

Statistical Analysis

The data obtained by W.S. were analyzed under release 79.5 of SAS at the University of Iowa Computer Center.

Univariate Analysis

A univariate analysis of the raw data for the eleven measurements resulted in descriptive statistics for thirteen variables.

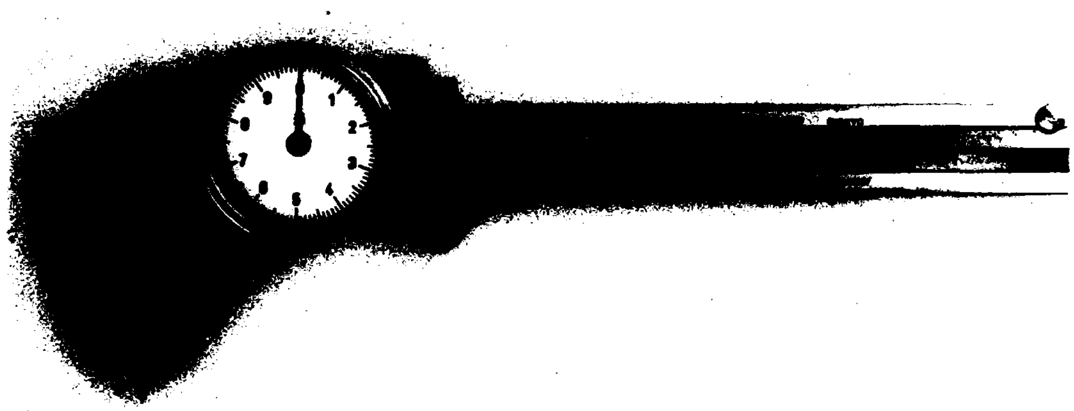

Figure 12. Helios dial caliper.

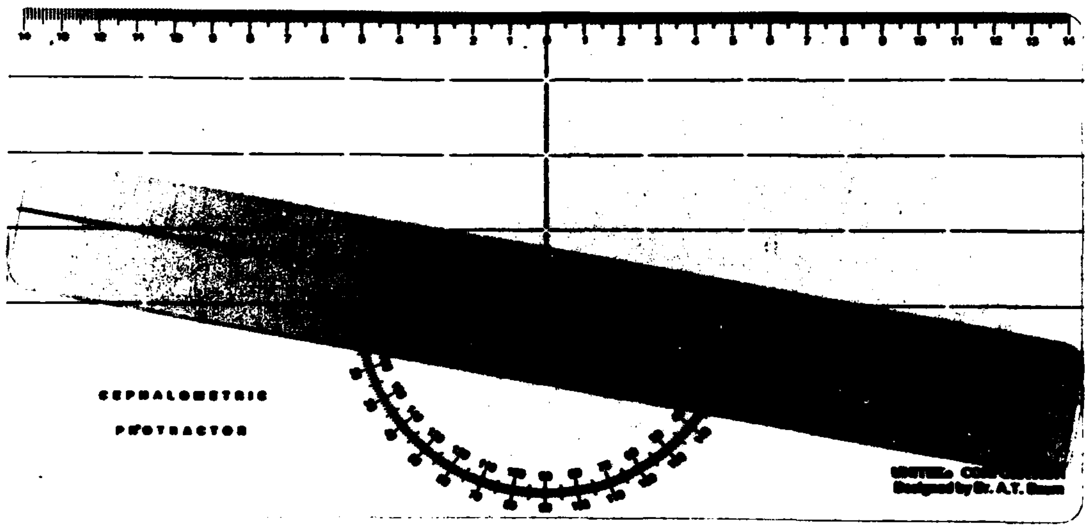

Figure 13. Baum cephalometric protractor.

General Linear Models Procedure and Duncan's Multiple Range Test

A general linear models procedure was used to determine if differences existed between the four groups. F values were calculated and Duncan's tests were performed on all variables. The Duncan's test is a procedure which simultaneously compares means of multiple groups in order to delineate differences between the groups while classifying similar groups together. An alpha of 0.05 was chosen.

Correlations

Correlation coefficients were calculated for all possible pairs of variables within each group and within each Angle classification. Correlation is a measure of the degree to which the variables vary together, or as a measure of the intensity of association. Correlations were determined to be statistically significant when calculated p values were equal to or less than 0.05.

FINDINGS

Raw Data

The raw data and six correlation matrices are not included in this report but are available at the University of Iowa Department of Orthodontics.

Descriptive Statistics

Descriptive statistics were calculated for the thirteen measurement variables. The mean, standard deviation, minimum value and maximum value are presented in Tables 1 through 4 (Appendix A).

General Linear Models Procedure

Three of the thirteen variables showed no significant difference among the four groups while ten of the variables showed significant differences among the groups. The three variables which showed no difference were mandibular intercanine width, overbite and mandibular plane angle. The results are summarized in Table 5 (Appendix B).

Duncan's Multiple Range Test

Duncan's Multiple Range Tests were run on all variables. These results are reported in Table 6 (Appendix B).

The findings indicate that the maxillary intermolar width was significantly larger in Class I males than in any of the other three groups and significantly larger in Class I females than in either

Class II males or females. The Class I males (group A) had a mean intermolar width of 54.71 mm, the Class I females (group B) had a mean intermolar width of 50.16 mm and the Class II males and females (group C) had mean intermolar widths of 47.34 mm and 46.31 mm respectively.

Maxillary alveolar width findings indicated Class I males (group A) were significantly larger than Class I females and Class II males (group B) who in turn were significantly larger than Class II females (group C). The Class I males had a mean maxillary alveolar width of 61.59 mm while the Class I females and Class II males had means of 56.68 mm and 55.36 mm respectively and the Class II females had a mean of 53.46 mm.

The findings for maxillary intercanine width indicated a significantly larger dimension for Class I males (group A) than the other three groups. Class I females (group B) were larger than Class II females (group C) but not significantly larger than Class II males (groups B and C). The Class I males had mean maxillary intercanine width of 36.22 mm, the Class I females had a mean of 33.22 mm and the Class II males and females had mean maxillary intercanine distances of 32.51 mm and 31.57 mm respectively.

In the mandibular arch the findings for intermolar width indicated that the Class I males (group A) were significantly larger than any of the other three groups (group B) who were all similar. The Class I males had a mean mandibular intermolar width of 53.14 mm while the Class II males, Class I females and Class II females had means of 50.20 mm, 49.00 mm and 48.67 mm respectively.

Mandibular alveolar width findings indicated that Class I males (group A) were significantly larger than Class II males (group B) who in turn were larger than either Class II or Class I females (group C). The mean mandibular alveolar width was 58.38 mm for Class I males, 56.28 mm for Class II males, 54.13 mm for Class II females and 53.96 mm for Class I females.

There were no significant differences among the four groups for mandibular intercanine width.

The results for the molar difference, or the maxillary intermolar width minus the mandibular intermolar width, revealed that the Class I males and females (group A) had a significantly larger difference than the Class II males and females (group B) whose mean differences were negative. The mean molar difference for the Class I males and females were 1.57 mm, and 1.16 mm respectively. The molar differences for the Class II females and males were -2.36 mm and -2.86 mm respectively.

Findings for alveolar difference, or the maxillary alveolar width at the first molar minus the mandibular alveolar width at the first molar, demonstrated that the Class I males and females (group A) were significantly different from the Class II males and females (group B). The mean alveolar difference for Class I males was 3.21 mm and 2.72 mm for Class I females. The mean alveolar differences for Class II males and females were negative; -0.68 mm for females and -0.92 mm for males.

The findings for canine difference, the maxillary intercanine distance minus the mandibular intercanine distance, indicated that the Class I males (group A) were significantly different from all other groups while Class I females (group B) were different from Class II females (group C). Class II males (groups B and C) were not statistically significantly different from either Class I females or Class II females. The Class I males had a mean canine difference of 9.95 mm, Class I females had a mean difference of 7.90 mm, Class II males had a mean difference of 6.99 mm and Class II females had a mean canine difference of 6.49 mm.

The Wits appraisal results indicate that Class II males and females (group A) were different from Class I males and females (group B). The means for the Wits appraisal was 6.54 mm for Class II males, 6.41 mm for Class II females, 0.23 mm for Class I males and -0.76 mm for Class I females.

The findings for overjet indicated that the Class II males and females (group A) were similar and that Class I females and males (group B) were similar. The findings showed a statistically significant difference between the Class II groups (males and females) and the Class I groups (males and females). The Class II females had a mean overjet of 11.04 mm, the Class II males had a mean overjet of 10.37 mm, the Class I females had a mean overjet of 2.51 mm and the Class I males had a mean overjet of 2.21 mm.

Correlations

Correlation coefficients for all combinations of variables were computed within each group (Class I females, Class I males, Class II females and Class II males) and within each Angle classification (Class I, sexes pooled and Class II, sexes pooled). Correlations were considered significant if the t-test indicated the correlation coefficient was significantly different from zero ($p \leq 0.05$). They are presented in Tables 7-9 (Appendix C). However, caution must be exercised due to the large number of correlations and the use of an alpha level of 0.05. Probability dictates that spurious correlations will occur when a p value of 0.05 is used with this many correlations.

Maxillary intermolar width had high positive correlations with maxillary alveolar width whether the sample was divided into four groups by sex and Angle classification, or into two groups by Angle classification only. It had moderate, positive correlations with mandibular intercanine width when the sample was divided similarly.

Maxillary alveolar width demonstrated strong to moderately strong, positive correlations with maxillary intermolar width and alveolar difference in all groups.

Maxillary intercanine width showed a moderately strong, positive correlation with mandibular intercanine width. Similar correlations were found for maxillary intercanine width and canine difference in all groups except Class I females. Moderately strong, positive correlations were found between maxillary intercanine width and maxillary alveolar width in all groups except the Class II females.

Mandibular intermolar width showed a strong, positive correlation with mandibular alveolar width in all groups and a strong, positive correlation with maxillary intermolar width in the Class I groups but failed to show a significant correlation in the Class II females, and only a moderately positive correlation in the Class II males and all Class II subjects combined.

Moderately strong, positive correlations were found between mandibular alveolar width and mandibular intercanine width in all groups except the Class II females.

Molar difference demonstrated a strong, positive correlation with alveolar difference in all groups.

A moderately positive correlation was found between canine difference and overbite in all groups except the Class II females.

The Wits appraisal, overjet and mandibular plane angle variables showed a few, erratic, mild to moderate correlations.

DISCUSSION

Significant differences were found among the four groups in this study. There were differences in the transverse and sagittal dimensions, both cephalometrically and dentally, however, the vertical parameters failed to demonstrate group divergence. Two general deductions from the statistical analysis were: 1) the Class I males were larger than the other groups in most of the dimensions measured and 2) the groups were divided according to Angle classification for many of the variables.

Transverse Measurements

The statistical analysis revealed that the Class I males had larger maxillae in all of the three transverse dimensions studied than did Class I females and Class II males and females. They also had significantly larger measurements for two of the three mandibular transverse dimensions; however, the mandibular intercanine width was not statistically different among the four groups.

The molar difference and alveolar difference measurements were significantly different for the Class I and Class II subjects. Class I subjects had positive mean values, indicating that the maxillary measurements were larger than the mandibular measurements. The Class II subjects had negative mean values, indicating that the maxillary measurements were smaller than the mandibular measurements, hence, a tendency for crossbite. Class I subjects, on the average, had a tendency toward normal buccal overjet in the first molar region of the dental arches while the Class II subjects had a tendency for crossbite in the molar region.

The alveolar difference was very similar to the molar differences. While the maxillary alveolar width minus the mandibular alveolar width in the first molar region tended to be positive in the Class I subjects it was negative on the average in the Class II subjects. This means that the Class I subjects had a wider maxillary alveolus in relation to the mandibular alveolus, while the Class II subjects had a narrower maxillary alveolus than mandibular alveolus. These findings suggest that in the subjects studied there was a significantly greater tendency for posterior crossbite in the Class II division 1 subjects than in the Class I subjects. This difference was evident in both the dental arches and in the basal bone widths.

These differences could possibly be explained in terms of a dental compensating mechanism which brought the teeth together in a "normal" buccolingual relationship to their opposing teeth. Since the maxillary first molar in a Class II individual occludes farther mesially on the mandibular arch than the maxillary first molar of a Class I individual, and since the mandibular arch narrows toward the mesial, the Class II individual's maxillary intermolar width would be smaller in relation to the mandibular intermolar width.

These findings are consistent with Solow (1966) who suggested such a dental compensatory mechanism when he found "jaw widths to be associated with the transverse inclination of the lateral dental arch segments in the opposite arch".

Since the mandibular intercanine width showed no significant differences among the four groups it appeared to be fairly stable regardless of molar relationship or sex. There were differences among the groups regarding maxillary intercanine width which were demonstrated by the similar groupings by the Duncan's test of both maxillary intercanine width and canine difference. The Class I males had a significantly greater intercanine width and canine difference than any other group. The Class I females had significantly greater maxillary intercanine widths and canine differences than did the Class II females. The Class II males could not be distinguished from either the Class I females or Class II females regarding either variable. It appears from this data that, excluding the Class I males who had larger measurements than the other three groups, the maxillary intercanine width and the canine difference measurements showed little difference among the three other groups. A conclusion from the results of this study is that while a clear difference between Class I and Class II subjects was found for the width measurements in the molar region, a less clear differentiation emerged from the canine width measurements. In fact, the mandibular intercanine width did not differ among the four groups. Clinical implications would include a greater necessity for crossbite correction in Class II division 1 adults of similar background as found in these samples, and basing the amount of correction necessary on the intermolar width rather than intercanine width.

The findings of this study are reasonably consistent with Frohlich (1961, 1962) but differ in some areas. He found his Class II division 1 sample had maxillary intermolar widths smaller than the normative data. The findings of this study also indicated that the Class I groups had larger maxillary intermolar widths than the Class II groups. He had growing children and did not divide them by sex while this study was based on non-growing individuals categorized by Angle classification and sex.

Concerning maxillary intercanine width Frohlich (1961, 1962) found one of his four Class II groups to have below average width, one to have average width and two to have above average width. The present study showed both male and female Class II subjects to have significantly smaller maxillary intercanine width than Class I males and the Class II females to be significantly smaller than Class I females.

Anteroposterior Measurements

Statistical analysis of the Wits appraisal, or the amount of sagittal discrepancy of the denture bases with reference to the occlusal plane, separated the groups according to Angle classification. The mean distance the maxillary denture base was anterior to the mandibular denture base was significantly greater in the Class II subjects than in the Class I subjects. The Wits appraisal clearly demarcated two different populations and appears to be a useful clinical diagnostic tool to differentiate and describe Class I and Class II patients in terms of the denture base relationship between the upper and lower jaws.

Green (1968) found no difference in the forward projection of either upper or lower jaw between Class I and Class II children but he found that differences for upper and lower face depths were greater for Class II than Class I subjects. The findings of this study concerning Wits appraisal are consistent with his finding regarding differences in upper and lower face depths for Class II and Class I subjects.

The overjet measurements also divided the groups into two distinct groups according to Angle classification. As expected, the Class II subjects had a significantly larger mean overjet than the Class I subjects. This would logically follow since the maxillary arch of all Class II subjects was placed relatively anterior to the mandibular arch as compared to Class I subjects. This along with the crowding, spacing and incisor angulation criteria used in this study dictated that the Class II subjects would have a significantly larger mean overjet than the Class I subjects. There were no significant differences between Class II males and females, nor were there any significant differences between Class I males and females.

Vertical Measurements

Statistical analysis of overbite proved somewhat interesting since the general linear models procedure showed that differences among the four groups fell just short of being significant

(F value = 2.52, p = 0.06). Perhaps additional numbers of subjects or different samples might demonstrate differences which are statistically significant.

Statistical analysis of the mandibular plane angle, a cephalometric skeletal measure of vertical relationships, revealed no significant differences among the four groups. The mean mandibular plane angle for the groups ranged from 29.05° for Class I males to 33.86° for Class II females. The results of this study lead to the conclusion that the mandibular plane angle and Angle relationship of the teeth in these subjects were not highly related.

Correlations

Most of the significant correlations were found among the arch width and skeletal width measurements. Anteroposterior variables showed a few mild to moderate correlations but little consistency while vertical variables demonstrated few significant correlations with one exception. The Class II males had 29 significant correlations while the Class I males had 26, Class I females 21 and Class II females 18.

The transverse variables demonstrated frequent, significant correlations except for maxillary alveolar width in the combined Class II sample, and the mandibular alveolar width when the four groups were considered separately. The maxillary alveolar width did not significantly correlate with either the mandibular intermolar width or the mandibular alveolar width in the combined Class II group. Due to the proximity of the landmarks used for making transverse measurements, a fairly close interrelationship among these variables was expected. One notable difference between the Class I and Class II subjects was the strong correlation (r=0.77) in the Class I subjects between maxillary and mandibular alveolar widths and no significant correlation for the same width measurements in the Class II group. The reason for the lack of a strong association of these widths in the Class II group may be related to a greater variation in these widths in the Class II group as evidenced in Tables 1 through 4.

Other interesting findings include approximately equal correlation coefficients for maxillary intercanine width to mandibular intercanine width in the Class I (r=0.68) and Class II (r=0.62) subjects. The maxillary intermolar width to mandibular intermolar width correlation coefficients for Class I (r=0.90) and Class II (r=0.46) subjects did not follow this trend indicating more variance in the molar region for the Class II subjects than the Class I subjects but approximately the same amount of variance in the canine region of both groups.

There were no significant correlations between the canine difference and the mandibular intercanine width in either Class I or Class II groups while there were moderately positive correlations between canine difference and maxillary intercanine width in both groups. A possible conclusion could be that the canine difference varied as the maxillary intercanine width varied but was largely independent of changes in the mandibular intercanine width.

The alveolar difference was closely associated with both the maxillary alveolar width and the molar difference in all groups.

The alveolar difference showed no significant correlation to mandibular alveolar width in the Class I subjects but showed moderately strong, negative correlation with mandibular alveolar width in the Class II subjects.

Possible interrelationships between anteroposterior, transverse and vertical variables were minimal. However, it was interesting to note that overbite and canine difference had moderate to moderately strong, positive correlations in three of the four groups. They also showed a fair to moderately positive relationship in both Class I combined and Class II combined groups. These findings generally agree with Solow (1968) who found no associations between the widths of the dental arches and the sagittal jaw relationship.

The present study tends to reinforce the independence of transverse, sagittal and vertical dimensions of the dental arches and apical bases. It also provides some normative data for Class I and Class II division 1 individuals of similar backgrounds to those studied. The Wits appraisal was shown to be a useful adjunct in determining Class II versus Class I apical base relationships and a set of standards is now available for Class II as well as Class I individuals. The findings of this study have clinical relevance in that they demonstrate a tendency for posterior crossbite which extends beyond the dental arches and into the apical bases in the Class II subjects. They also show that this crossbite tendency occurs in the molar but not the canine region. The mandibular intercanine width was found to be very constant among all groups which may have implications concerning mandibular arch development, expansion and relapse in orthodontic treatment.

Speculation as to why these differences and similarities were found could lead one to surmize that possibly there are genetic differences between these two populations which are expressed by the divergence shown in this study. Possibly environmental influences, such as mouth breathing, tongue posture and habits, are responsible for some of the differences seen. Functional demands might also have played a role in differentiating the Class II subjects' morphology from the Class I individuals'. Therefore, further study along many related areas would seem beneficial.

Suggestions for Further Study

A statistical analysis of other malocclusion types with comparison to each other as well as the groups in this study might prove fruitful. Possible groups to include would be Class II division 2 and Class III malocclusion in non-growing individuals. More variables such as width measurements from posterior-anterior cephalograms and vertical cephalometric measurements could be added and compared among groups.

Another possible area of study would be to compare alveolar and arch width differences with posterior bite depth to investigate the possibility that a dental compensatory mechanism relates the teeth properly buccolingually but, in so doing, angulates the teeth such that the lingual cusps of the upper molars move inferiorly or superiorly in relation to the occlusal plane, changing the bite depth.

Other racial groups as well as subjects of different ages or stages of development might be used in a similar study.

A multivariate analysis relating the Wits appraisal to other cephalometric parameters such as mandibular plane angle or the angle formed by the occlusal plane and Frankfort horizontal could possibly provide useful diagnostic information for an accurate assessment of anteroposterior jaw relationships.

SUMMARY

The purpose of this study was to examine some arch width and skeletal similarities and differences among orthodontically untreated, non-growing, Angle Class I and Class II division 1 males and females. Plaster models and cephalograms were examined from 36 Class I subjects from the Iowa Growth Study and 39 Class II subjects from the Orthodontic Department at the University of Iowa College of Dentistry. Nine plaster model measurements and two cephalometric measurements combined to form thirteen variables which were statistically analyzed using the General Linear Models procedure, Duncan's Multiple Range Test and a correlation matrix.

The following findings are based on the above mentioned statistical analysis.

1) Class I males were larger than the other three groups for the following transverse measurements: maxillary intermolar width, maxillary alveolar width, maxillary intercanine width, mandibular intermolar width and mandibular alveolar width.

2) Significant width differences occurred between Class I and Class II subjects for maxillary intermolar width, molar difference and alveolar difference.

3) There was a tendency for posterior crossbite in the Class II subjects relative to the Class I subjects.

4) A pronounced difference was found between Class I and Class II subjects regarding overjet and Wits appraisal, the Class II subjects having larger values for both parameters.

5) No difference was found among the groups concerning mandibular intercanine width as well as the vertical measures of overbite and mandibular plane angle.

6) A sex difference was demonstrated for mandibular alveolar width, males being larger than females.

7) Arch width variables were generally highly correlated with other arch width variables with the exception of maxillary alveolar width in the Class II subjects.

8) Transverse-sagittal, transverse-vertical and sagittal-vertical correlations were generally mild or lacking except for the canine difference-overbite correlation which was moderately strong in all groups, except Class II females.

APPENDIX A

DESCRIPTIVE STATISTICS

Table 1

Descriptive Statistics for All Variables

Class I Males

Variable	N	Mean[1]	Standard Deviation[1]	Minimum Value[1]	Maximum Value[1]
Maxillary Intermolar Width	19	54.71	2.13	51.43	57.98
Maxillary Alveolar Width	19	61.59	2.92	57.18	67.90
Maxillary Intercanine Width	19	36.22	2.26	39.90	41.88
Mandibular Intermolar Width	19	53.14	1.63	50.20	56.03
Mandibular Alveolar Width	19	58.38	1.71	55.28	61.60
Mandibular Intercanine Width	19	26.27	1.80	23.35	31.03
Molar Difference[2]	19	1.57	1.44	-0.50	4.35
Alveolar Difference[3]	19	3.21	2.28	-0.03	8.03
Canine Difference[4]	19	9.95	1.54	7.20	11.98
Wits	19	0.23	2.09	-5.00	4.39
Overjet	19	2.21	0.75	0.83	3.45
Overbite	19	45.45%	19.78%	9.22%	83.02%
Mandibular Plane Angle	19	29.05°	6.59°	15.00°	43.00°

[1]Measurements are reported in millimeters except for the variables overbite and mandibular plane angle which are reported in percentage and degrees respectively.

[2]Molar Difference = maxillary intermolar width minus mandibular intermolar width.

[3]Alveolar Difference = maxillary alveolar width minus mandibular alveolar width in the first molar region.

[4]Canine Difference = maxillary intercanine width minus mandibular intercanine width.

Table 2

Descriptive Statistics for All Variables

Class II Males

Variable	N	Mean[1]	Standard Deviation[1]	Minimum Value[1]	Maximum Value[1]
Maxillary Intermolar Width	20	47.34	3.01	41.53	55.03
Maxillary Alveolar Width	20	55.36	2.86	50.30	61.25
Maxillary Intercanine Width	20	32.51	2.07	30.20	39.78
Mandibular Intermolar Width	20	50.20	3.13	44.65	57.35
Mandibular Alveolar Width	20	56.28	2.41	51.95	61.30
Mandibular Intercanine Width	20	25.52	2.04	21.85	32.23
Molar Difference[2]	20	-2.86	3.07	-12.48	0.68
Alveolar Difference[3]	20	-0.92	3.34	-8.73	4.70
Canine Difference[4]	20	6.99	1.76	3.38	10.05
Wits	20	6.54	3.09	-0.44	12.50
Overjet	20	10.37	1.34	7.85	12.45
Overbite	20	53.93%	25.67%	8.26%	100.00%
Mandibular Plane Angle	20	29.28°	8.08°	18.50°	43.00°

[1]Measurements are reported in millimeters except for the variables overbite and mandibular plane angle which are reported in percentage and degrees respectively.

[2]Molar Difference = maxillary intermolar width minus mandibular intermolar width.

[3]Alveolar Difference = maxillary alveolar width minus mandibular alveolar width in the first molar region.

[4]Canine Difference = maxillary intercanine width minus mandibular intercanine width.

Table 3

Descriptive Statistics for All Variables

Class I Females

Variable	N	Mean[1]	Standard Deviation[1]	Minimum Value[1]	Maximum Value[1]
Maxillary Intermolar Width	17	50.16	2.05	46.65	54.08
Maxillary Alveolar Width	17	56.68	2.44	53.18	60.43
Maxillary Intercanine Width	17	33.22	1.37	31.30	35.45
Mandibular Intermolar Width	17	49.00	1.83	46.43	52.93
Mandibular Alveolar Width	17	53.96	1.55	51.48	57.20
Mandibular Intercanine Width	17	25.33	1.50	22.65	28.20
Molar Difference[2]	17	1.16	1.20	-1.28	4.30
Alveolar Difference[3]	17	2.72	2.45	-1.48	7.08
Canine Difference[4]	17	7.90	1.36	5.73	10.30
Wits	17	-0.76	2.18	-5.87	2.61
Overjet	17	2.51	1.13	1.28	4.35
Overbite	17	35.99%	13.38%	17.97%	60.39%
Mandibular Plane Angle	17	32.16°	5.36°	23.00°	43.00°

[1]Measurements are reported in millimeters except for the variables overbite and mandibular plane angle which are reported in percentage and degrees respectively.

[2]Molar Difference = maxillary intermolar width minus mandibular intermolar width.

[3]Alveolar Difference = maxillary alveolar width minus mandibular alveolar width in the first molar region.

[4]Canine Difference = maxillary intercanine width minus mandibular intercanine width.

Table 4

Descriptive Statistics for All Variables

Class II Females

Variable	N	Mean[1]	Standard Deviation[1]	Minimum Value[1]	Maximum Value[1]
Maxillary Intermolar Width	19	46.31	2.11	41.98	50.18
Maxillary Alveolar Width	19	53.46	2.46	50.03	57.35
Maxillary Intercanine Width	19	31.57	2.47	27.35	35.75
Mandibular Intermolar Width	19	48.67	2.46	43.73	53.98
Mandibular Alveolar Width	19	54.13	2.17	50.60	59.53
Mandibular Intercanine Width	19	25.09	1.96	21.08	28.63
Molar Difference[2]	19	-2.36	2.69	-8.98	0.43
Alveolar Difference[3]	19	-0.68	3.09	-8.90	4.83
Canine Difference[4]	19	6.49	2.02	3.88	11.25
Wits	19	6.41	2.39	0.88	10.09
Overjet	19	11.04	1.23	8.70	13.18
Overbite	19	51.36%	23.35%	11.81%	89.52%
Mandibular Plane Angle	19	33.86°	7.77°	18.75°	50.75°

[1]Measurements are reported in millimeters except for the variables overbite and mandibular plane angle which are reported in percentage and degrees respectively.

[2]Molar Difference = maxillary intermolar width minus mandibular intermolar width.

[3]Alveolar Difference = maxillary alveolar width minus mandibular alveolar width in the first molar region.

[4]Canine Difference = maxillary intercanine width minus mandibular intercanine width.

APPENDIX B

GENERAL LINEAR MODELS PROCEDURE AND DUNCAN'S MULTIPLE RANGE TEST

Table 5

General Linear Models Procedure

All Variables - All Groups

Variable	N	F value	PR > F[1]
Maxillary Intermolar Width	75	47.75	0.0001
Maxillary Alveolar Width	75	31.89	0.0001
Maxillary Intercanine Width	75	17.41	0.0001
Mandibular Intermolar Width	75	13.88	0.0001
Mandibular Alveolar Width	75	19.99	0.0001
Mandibular Intercanine Width	75	1.44	0.2363*
Molar Difference[2]	75	19.32	0.0001
Alveolar Difference[3]	75	11.17	0.0001
Canine Difference[4]	75	15.50	0.0001
Wits	75	45.85	0.0001
Overjet	75	336.65	0.0001
Overbite	75	2.52	0.0641*
Mandibular Plane Angle	75	2.05	0.1129*

[1]Probability value for F test - significant difference determined at $p \leq 0.05$.

[2]Molar Difference = maxillary intermolar width minus mandibular intermolar width.

[3]Alveolar Difference = maxillary alveolar width minus mandibular alveolar width in the first molar region.

[4]Canine Difference = maxillary intercanine width minus mandibular intercanine width.

*No significant difference among the four groups.

Table 6

Comparison of Class I Males, Class I Females, Class II Males and Class II Females

General Linear Models Procedure				Duncan's Multiple Range Test			
Variable	N	F value	PR<F[1]	Group Letter[2]	Mean[3]	N	Subgroup
Maxillary Inter-molar Width	75	47.75	0.0001	A	54.71	19	Class I Males
				B	50.16	17	Class I Females
				C	47.34	20	Class II Males
				C	46.31	19	Class II Females
Maxillary Alveolar Width	75	31.89	0.0001	A	61.59	19	Class I Males
				B	56.68	17	Class I Females
				B	55.36	20	Class II Males
				C	53.46	19	Class II Females
Maxillary Inter-canine Width	75	17.41	0.0001	A	36.22	19	Class I Males
				B	33.22	17	Class I Females
				B C	32.51	20	Class II Males
				C	31.57	19	Class II Females
Mandibular Inter-molar Width	17	13.88	0.0001	A	53.14	19	Class I Males
				B	50.20	20	Class II Males
				B	49.00	17	Class I Females
				B	48.67	19	Class II Females

Table 6 (Continued)

General Linear Models Procedure				Duncan's Multiple Range Test			
Variable	N	F value	PR<F[1]	Group Letter[2]	Mean[3]	N	Subgroup
Mandibular Alveolar Width	75	19.99	0.0001	A	58.38	19	Class I Males
				B	56.28	20	Class II Males
				C	54.13	19	Class II Females
				C	53.96	17	Class I Females
Mandibular Inter-canine Width	75	1.44	0.2363	A	26.27	19	Class I Males
				A	25.52	20	Class II Males
				A	25.33	17	Class I Females
				A	25.09	19	Class II Females
Molar Difference	75	19.32	0.0001	A	1.57	19	Class I Males
				A	1.16	17	Class I Females
				B	-2.36	19	Class II Females
				B	-2.86	20	Class II Males
Alveolar Difference	75	11.17	0.0001	A	3.21	19	Class I Males
				A	2.72	17	Class I Females
				B	-0.68	19	Class II Females
				B	-0.92	20	Class II Males
Canine Difference	75	15.50	0.0001	A	9.95	19	Class I Males
				B	7.90	17	Class I Females
				B C	6.99	20	Class II Males
				C	6.49	19	Class II Females

Table 6 (Continued)

General Linear Models Procedure				Duncan's Multiple Range Test			
Variable	N	F value	PR<F[1]	Group Letter[2]	Mean[3]	N	Subgroup
Wits	75	45.85	0.0001	A	6.54	20	Class II Males
				A	6.41	19	Class II Females
				B	0.23	19	Class I Males
				B	-0.76	17	Class I Females
Overjet	75	336.65	0.0001	A	11.04	19	Class II Females
				A	10.37	20	Class II Males
				B	2.51	17	Class I Females
				B	2.21	19	Class I Males
Overbite	75	2.52	0.0641	A	53.93%	20	Class II Males
				A	51.36%	19	Class II Females
				A B	45.45%	19	Class I Males
				B	35.99%	17	Class I Females
Mandibular Plane Angle	75	2.05	0.1129	A	33.86°	19	Class II Females
				A	32.16°	17	Class I Females
				A	29.28°	20	Class II Males
				A	29.05°	19	Class I Males

[1]Probability value for F test, significant difference determined at $P < 0.05$.

[2]Significant difference between group determined at $p < 0.05$, subgroups with the same letter are not significantly different.

[3]Measurements are reported in millimeters except for the variables overbite and mandibular plane angle which are reported in percentage and degrees respectively.

APPENDIX C

CORRELATIONS

Table 7

Significant Correlations in All Groups

First Variable	Second Variable	Number of Correlations	Groups: Class I Females (N=17) PR	r	Class I Males (N=19) PR	r	Class II Females (N=19) PR	r	Class II Males (N=20) PR	r
Maxillary Intermolar Width	Maxillary Alveolar Width	4	0.0004	0.76	0.0001	0.78	0.0001	0.80	0.0001	0.76
	Maxillary Intercanine Width	3	0.0424	0.50	0.0037	0.63			0.0084	0.57
	Mandibular Intermolar Width	3	0.0001	0.81	0.0003	0.74			0.0250	0.50
	Mandibular Alveolar Width	2	0.0128	0.59	0.0006	0.71				
	Mandibular Intercanine Width	4	0.0180	0.57	0.0156	0.55	0.0488	0.46	0.0246	0.50
	Molar Difference	3			0.0030	0.64	0.0304	0.50	0.0372	0.47
	Alveolar Difference	1			0.0437	0.47				
Maxillary Alveolar Width	Maxillary Intermolar Width	4	0.0004	0.76	0.0001	0.78	0.0001	0.80	0.0001	0.76
	Maxillary Intercanine Width	3	0.0198	0.56	0.0007	0.71			0.0009	0.68
	Mandibular Intermolar Width	2	0.0369	0.51	0.0401	0.47				
	Mandibular Alveolar Width	1			0.0041	0.63				
	Mandibular Intercanine Width	2	0.0093	0.61	0.0157	0.55				
	Molar Difference	3	0.0280	0.53	0.0050	0.62			0.0148	0.54
	Alveolar Difference	4	0.0001	0.80	0.0001	0.81	0.0006	0.72	0.0005	0.71
	Mandibular Plane Angle	1					0.0033	-0.64		
Maxillary Intercanine Width	Maxillary Intermolar Width	3	0.0424	0.50	0.0037	0.63			0.0084	0.57
	Maxillary Alveolar Width	3	0.0198	0.56	0.0007	0.71			0.0009	0.68
	Mandibular Intermolar Width	3	0.0145	0.58	0.0370	0.48	0.0367	0.48		
	Mandibular Alveolar Width	2			0.0020	0.66				
	Mandibular Intercanine Width	4	0.0212	0.55	0.0004	0.73	0.0058	0.61	0.0026	0.64
	Canine Difference	3			0.0059	0.61	0.0035	0.63	0.0499	0.44
	Overjet	1			0.0356	0.48				
Mandibular Intermolar Width	Maxillary Intermolar Width	3	0.0001	0.81	0.0003	0.74			0.0250	0.50
	Maxillary Alveolar Width	2	0.0369	0.51	0.0401	0.47				
	Maxillary Intercanine Width	3	0.0145	0.58	0.0370	0.48	0.0367	0.48		
	Mandibular Alveolar Width	4	0.0001	0.86	0.0002	0.76	0.0001	0.84	0.0001	0.89
	Mandibular Intercanine	3	0.0052	0.64	0.0120	0.56			0.0016	0.66
	Molar Difference	2					0.0018	-0.67	0.0159	-0.53
	Alveolar Difference	1							0.0357	-0.47
	Overbite	1							0.0422	-0.46
Mandibular Alveolar Width	Maxillary Intermolar Width	2	0.0128	0.59	0.0006	0.71				
	Maxillary Alveolar Width	1			0.0041	0.63				
	Maxillary Intercanine Width	1			0.0020	0.66				
	Mandibular Intermolar Width	4	0.0001	0.86	0.0002	0.76	0.0001	0.84	0.0001	0.89
	Mandibular Intercanine Width	3	0.0164	0.57	0.0040	0.63			0.0003	0.72
	Molar Difference	2					0.0131	-0.56	0.0260	-0.50
	Alveolar Difference	2					0.0054	-0.61	0.0125	-0.55
	Canine Difference	1							0.0075	-0.58
	Overjet	1	0.0402	0.50						
	Overbite	1							0.0122	-0.55
Mandibular Intercanine Width	Maxillary Intermolar Width	4	0.0180	0.57	0.0156	0.55	0.0488	0.46	0.0246	0.50
	Maxillary Alveolar Width	2	0.0093	0.61	0.0157	0.55				
	Maxillary Intercanine Width	4	0.0212	0.55	0.0004	0.73	0.0058	0.61	0.0026	0.64
	Mandibular Intermolar Width	3	0.0052	0.64	0.0120	0.56			0.0016	0.66
	Mandibular Alveolar Width	3	0.0164	0.57	0.0040	0.63			0.0003	0.72
	Canine Difference	1	0.0240	-0.54						

Table 7 (Continued)

First Variable	Second Variable	Number of Correlations	Groups: Class I Females (N=17) PR[1]	r	Class I Males (N=19) PR[1]	r	Class II Females (N=19) PR[1]	r	Class II Males (N=20) PR[1]	r
Molar Difference	Maxillary Intermolar Width	3			0.0030	0.64	0.0304	0.50	0.0372	0.47
	Maxillary Alveolar Width	4	0.0280	0.53	0.0050	0.62			0.0148	0.54
	Mandibular Intermolar Width	2					0.0018	-0.67	0.0159	-0.53
	Mandibular Alveolar Width	2					0.0131	-0.56	0.0260	-0.50
	Alveolar Difference	4	0.0011	0.72	0.0027	0.65	0.0003	0.73	0.0001	0.82
	Canine Difference	1							0.0329	0.48
	Overjet						0.0471	0.46		
	Overbite	2			0.0042	0.63			0.0247	0.50
Alveolar Difference	Maxillary Intermolar Width	1			0.0437	0.47				
	Maxillary Alveolar Width	4	0.0001	0.80	0.0001	0.81	0.0006	0.72	0.0005	0.71
	Mandibular Intermolar Width	1							0.0357	-0.47
	Mandibular Alveolar Width	2					0.0054	-0.61	0.0125	-0.55
	Molar Difference	4	0.0011	0.72	0.0027	0.65	0.0003	0.73	0.0001	0.82
	Canine Difference	1							0.0004	0.71
	Wits Appraisal	1							0.0312	0.48
	Overjet	1					0.0045	0.62		
	Overbite	1							0.0002	0.73
	Mandibular Plane Angle	1					0.0149	-0.55		
Canine Difference	Maxillary Intercanine Width	3			0.0059	0.61	0.0035	0.63	0.0499	0.44
	Mandibular Alveolar Width	1							0.0075	-0.58
	Mandibular Intercanine Width	1	0.0240	-0.54						
	Molar Difference	1							0.0329	0.48
	Alveolar Difference	1							0.0004	0.71
	Overbite	3	0.0006	0.74	0.0200	0.53			0.0249	0.50
	Mandibular Plane Angle	1			0.0006	-0.71				
Wits Appraisal	Alveolar Difference	1							0.0312	0.48
	Overjet	1	0.0341	0.52						
	Overbite	1							0.0309	0.48
Overjet	Maxillary Intercanine Width	1			0.0356	0.48				
	Mandibular Alveolar Width	1	0.0402	0.50						
	Molar Difference	1					0.0471	0.46		
	Alveolar Difference	1					0.0045	0.62		
	Wits	1	0.0341	0.52						
	Mandibular Plane Angle	2	0.0251	0.54			0.0363	-0.48		
Overbite	Mandibular Intermolar Width	1							0.0422	-0.46
	Mandibular Alveolar Width	1							0.0122	-0.55
	Molar Difference	2			0.0042	0.63			0.0247	0.50
	Alveolar Difference	1							0.0002	0.73
	Canine Difference	3	0.0006	0.74	0.0200	0.53			0.0249	0.50
	Wits Appraisal	1							0.0309	0.48
	Mandibular Plane Angle	2			0.0053	-0.61			0.0500	-0.44
Mandibular Plane	Maxillary Alveolar Width	1					0.0033	-0.64		
	Alveolar Difference	1					0.0149	-0.55		
	Canine Difference	1			0.0006	-0.71				
	Overjet	2	0.0251	0.54			0.0363	-0.48		
	Overbite	2			0.0053	-0.61			0.0500	-0.44

[1] Probability value for student's t test, N-2 degrees of freedom, $\alpha = 0.05$.

Table 8

Correlations Between All Variables in Class I Subjects
(N=36)

First Variable	Second Variable	r	PR < r
Maxillary Intermolar Width	Maxillary Alveolar Width	0.88	0.0001
	Maxillary Intercanine Width	0.77	0.0001
	Mandibular Intermolar Width	0.90	0.0001
	Mandibular Alveolar Width	0.86	0.0001
	Mandibular Intercanine Width	0.56	0.0004
	Molar Difference	0.49	0.0024
	Alveolar Difference	0.36	0.0296
	Canine Difference	0.50	0.0021
	Overbite	0.38	0.0238
	Mandibular Plane Angle	-0.34	0.0447
Maxillary Alveolar Width	Maxillary Intermolar Width	0.88	0.0001
	Maxillary Intercanine Width	0.80	0.0001
	Mandibular Intermolar Width	0.75	0.0001
	Mandibular Alveolar Width	0.77	0.0001
	Mandibular Intercanine Width	0.59	0.0001
	Molar Difference	0.53	0.0010
	Alveolar Difference	0.65	0.0001
	Canine Difference	0.52	0.0013
	Overbite	0.41	0.0137
	Mandibular Plane Angle	-0.36	0.0287
Maxillary Intercanine Width	Maxillary Intermolar Width	0.77	0.0001
	Maxillary Alveolar Width	0.80	0.0001
	Mandibular Intermolar Width	0.73	0.0001
	Mandibular Alveolar Width	0.76	0.0001
	Mandibular Intercanine Width	0.68	0.0001

Table 8 (Continued)

First Variable	Second Variable	r	PR < r
	Alveolar Difference	0.35	0.0347
	Canine Difference	0.70	0.0001
	Overbite	0.40	0.0166
Mandibular Intermolar Width	Maxillary Intermolar Width	0.90	0.0001
	Maxillary Alveolar Width	0.75	0.0001
	Maxillary Intercanine Width	0.73	0.0001
	Mandibular Alveolar Width	0.93	0.0001
	Mandibular Intercanine Width	0.58	0.0002
	Canine Difference	0.44	0.0076
Mandibular Alveolar Width	Maxillary Intermolar Width	0.86	0.0001
	Maxillary Alveolar Width	0.77	0.0001
	Maxillary Intercanine Width	0.76	0.0001
	Mandibular Intermolar Width	0.93	0.0001
	Mandibular Intercanine Width	0.57	0.0003
	Canine Difference	0.48	0.0029
Mandibular Intercanine Width	Maxillary Intermolar Width	0.56	0.0004
	Maxillary Alveolar Width	0.59	0.0001
	Maxillary Intercanine Width	0.68	0.0001
	Mandibular Intermolar Width	0.58	0.0002
	Mandibular Alveolar Width	0.57	0.0003
Molar Difference	Maxillary Intermolar Width	0.49	0.0024
	Maxillary Alveolar Width	0.53	0.0010
	Alveolar Difference	0.68	0.0001
	Overbite	0.48	0.0029

Table 8 (Continued)

First Variable	Second Variable	r	PR < r
Alveolar Difference	Maxillary Intermolar Width	0.36	0.0296
	Maxillary Alveolar Width	0.65	0.0001
	Maxillary Intercanine Width	0.35	0.0347
	Molar Difference	0.68	0.0001
Canine Difference	Maxillary Intermolar Width	0.50	0.0021
	Maxillary Alveolar Width	0.52	0.0013
	Maxillary Intercanine Width	0.70	0.0001
	Mandibular Intermolar Width	0.44	0.0076
	Mandibular Alveolar Width	0.48	0.0029
	Overbite	0.63	0.0001
	Mandibular Plane Angle	-0.50	0.0019
Overbite	Maxillary Intermolar Width	0.38	0.0238
	Maxillary Alveolar Width	0.41	0.0137
	Maxillary Intercanine Width	0.40	0.0166
	Molar Difference	0.48	0.0029
	Canine Difference	0.63	0.0001
	Mandibular Plane Angle	-0.41	0.0137
Mandibular Plane Angle	Maxillary Intermolar Width	-0.34	0.0447
	Maxillary Alveolar Width	-0.36	0.0287
	Canine Difference	-0.50	0.0019
	Overbite	-0.41	0.0137

Table 9

Correlations Between All Variables in Class II Subjects
(N=39)

First Variable	Second Variable	r	PR < r
Maxillary Intermolar Width	Maxillary Alveolar Width	0.77	0.0001
	Maxillary Intercanine Width	0.48	0.0019
	Mandibular Intermolar Width	0.46	0.0029
	Mandibular Alveolar Width	0.40	0.0106
	Mandibular Intercanine Width	0.49	0.0016
	Molar Difference	0.45	0.0043
	Alveolar Difference	0.36	0.0231
	Mandibular Plane Angle	-0.37	0.0197
Maxillary Alveolar Width	Maxillary Intermolar Width	0.77	0.0001
	Maxillary Intercanine Width	0.52	0.0007
	Mandibular Intercanine Width	0.38	0.0170
	Molar Difference	0.43	0.0064
	Alveolar Difference	0.65	0.00C1
	Wits	0.33	0.0422
	Overbite	0.38	0.0171
	Mandibular Plane Angle	-0.49	0.0018
Maxillary Intercanine Width	Maxillary Intermolar Width	0.48	0.0019
	Maxillary Alveolar Width	0.52	0.0007
	Mandibular Intermolar Width	0.42	0.0073
	Mandibular Alveolar Width	0.38	0.0162
	Mandibular Intercanine Width	0.62	0.0001
	Canine Difference	0.56	0.0002
	Mandibular Plane Angle	-0.35	0.0266
Mandibular Intermolar Width	Maxillary Intermolar Width	0.46	0.0029
	Maxillary Intercanine Width	0.42	0.0073

Table 9 (Continued)

First Variable	Second Variable	r	PR < r
	Mandibular Alveolar Width	0.87	0.0001
	Mandibular Intercanine Width	0.57	0.0002
	Molar Difference	-0.58	0.0001
	Alveolar Difference	-0.44	0.0047
	Overjet	-0.33	0.0384
Mandibular Alveolar Width	Maxillary Intermolar Width	0.40	0.0106
	Maxillary Intercanine Width	0.38	0.0162
	Mandibular Intermolar Width	0.87	0.0001
	Mandibular Intercanine Width	0.57	0.0002
	Molar Difference	-0.51	0.0010
	Alveolar Difference	-0.54	0.0004
	Overjet	-0.44	0.0048
Mandibular Intercanine Width	Maxillary Intermolar Width	0.49	0.0016
	Maxillary Alveolar Width	0.38	0.0170
	Maxillary Intercanine Width	0.62	0.0001
	Mandibular Intermolar Width	0.57	0.0002
	Mandibular Alveolar Width	0.57	0.0002
Molar Difference	Maxillary Intermolar Width	0.45	0.0043
	Maxillary Alveolar Width	0.43	0.0064
	Mandibular Intermolar Width	-0.58	0.0001
	Mandibular Alveolar Width	-0.51	0.0010
	Alveolar Difference	0.78	0.0001
Alveolar Difference	Maxillary Intermolar Width	0.36	0.0231
	Maxillary Alveolar Width	0.65	0.0001
	Mandibular Intermolar Width	-0.44	0.0047
	Mandibular Alveolar Width	-0.54	0.0004
	Molar Difference	0.78	0.0001

Table 9 (Continued)

First Variable	Second Variable	r	PR < r
	Wits	0.46	0.0030
	Overbite	0.50	0.0012
	Mandibular Plane Angle	-0.41	0.0089
Canine Difference	Maxillary Intercanine Width	0.56	0.0002
	Overbite	0.33	0.0403
	Mandibular Plane Angle	-0.33	0.0374
Wits	Maxillary Alveolar Width	0.33	0.0422
	Alveolar Difference	0.46	0.0030
	Overbite	0.38	0.0165
Overjet	Mandibular Intermolar Width	-0.33	0.0384
	Mandibular Alveolar Width	-0.44	0.0048
Overbite	Maxillary Alveolar Width	0.38	0.0171
	Alveolar Difference	0.50	0.0012
	Canine Difference	0.33	0.0403
	Wits	0.38	0.0165
	Mandibular Plane Angle	-0.42	0.0078
Mandibular Plane Angle	Maxillary Intermolar Width	-0.37	0.0197
	Maxillary Alveolar Width	-0.49	0.0018
	Maxillary Intercanine Width	-0.35	0.0266
	Alveolar Difference	-0.41	0.0089
	Canine Difference	-0.33	0.0374
	Overbite	-0.42	0.0078

BIBLIOGRAPHY

Angle, E.H., Classification of Malocclusion, Dent. Cosmos. 41:248-264, 350-357, 1899.

Bjork, A., Estimation of Age Changes in Overjet and Sagittal Jaw Relation, Trans. Europ. Orthod. Soc. 240-256 (126), 1953.

DeKock, W.H., Dental Arch Depth and Width Studied Longitudinally from 12 Years of Age to Adulthood, Am. J. Orthod. 62:56-66, 1972.

Frankel, M.R. and Kronman, J.H., A Cephalometric Evaluation of Craniofacial Landmarks and their Relationship to Intermolar (Mandibular) Dimensions, Angle Orth., Jul. 16:36(3):263-8.

Frohlich, F.J., A Longitudinal Study of Untreated Class II Type Malocclusion, Fr. Eur. Orth. Soc., pp. 137-151, 1961.

Frohlich, F.J., Changes in Untreated Class II Type Malocclusions, Angle Orthod. 32:167-179, 1962.

Green, L.J., Associations: Occlusion and Osseous Face, Angle Ortho. 38:40-50, 1968.

Jacobson, A., The "Wits" Appraisal of Jaw Disharmony, AJO 67(2), p. 125-138, 1975.

Knott, V.B., Size and Form of Dental Arches in Children with Good Occlusion Studied Longitudinally from Age 9 Years to Late Adolescence, Am. J. Phys. Anthrop. 19:263-284, 1961.

Knott, V.B., Longitudinal Study of Dental Arch Widths at Four Stages of Dentition, Angle Orthod. 42:387-394, 1972.

Moorrees, C.F.A., The Dentition of the Growing Child, Cambridge, 1959, Harvard University Press.

Moorrees, C.F.A., Variability of Dental and Facial Development, J. New York Acad. Sc. 134:846-857, 1966.

Moorrees, C.F.A. and Reed, R.B., Changes in Dental Arch Dimensions Expressed on the Basis of Tooth Eruption as a Measure of Biologic Age, J. Dent. Res. 44:129-141, 1965.

Moorrees, C.F.A., Gron, A.M., Lebret, L.M.L., Yen, P.K.J. and Frohlich, F.J., Growth Studies of the Dentition: A Review, AJO 55:600-616, 1969.

Rotberg, S., Fried, N., Kane, J. and Shapiro, E., Predicting the "Wits" Appraisal from the ANB Angle, AJO:77 (6), 636-642, June, 1980.

Sillman, J.H., Dimensional Changes of the Dental Arches: Longitudinal Study from Birth to 25 Years, Am. J. Orthod. 50:824-842, 1964.

Sillman, J.H., Some Aspects of Individual Dental Development, AJO 51:1-25, 1965.

Slagsvold, O., Associations in Width Dimensions of the Upper and Lower Jaws, Trans. Eur. Orthod. Soc. 1971:465-71.

Solow, B., The Pattern of Craniofacial Associations, Acta Odont. Scand., Vol. 24, Sup. 46, Copenhagen, 1966.

Warren, E., A Study of Correlation of Denture and Skeletal Widths, M.S. Thesis, University of Tenn., Nashville, 1959.

Woods, G.A. Jr., Changes in Width Dimensions between Certain Teeth and Facial Points During Human Growth, AJO 36:676-700, 1950.

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